than at Washington, at Cambridge than at Baltimore? The only way we can account for this is in the undoubtedly freer social life at the south, by which men are brought into more frequent collision, with consequent interchange of ideas; and this would lead one to conjecture, that, unless manners change, Boston and Cambridge cannot regain pre-eminence.

It is all very well to say with a complacent air that science does not depend on the public, and that her great discoveries are made far from the noisy world. It is only in exceedingly rare instances that they have been made by men whose scientific ardor was not born of contact with living teachers. And men who seek wisdom for themselves alone defraud the public; especially in these latter days, when it is this very public that is to furnish their successors in the investigation of nature. The public covets no man's scientific gold or apparel, but has a not altogether unwholesome yearning for a sight of it; and it is a travesty of the scientific spirit to keep it from view. Science may be a mild hermit: she can never be a miser.

But to return to Boston. The decadence noticed within the last ten years cannot be attributed to any change of general manners in the modern 'Athenian,' but must be sought in other local causes, and may be largely apparent. The increasing proportion of scientific men residing outside of Boston itself has much to do, during the colder and stormier season, with the small attendance at meetings which it takes an hour's travel to reach; and yet it is rare to find at any scientific gathering in Boston, even if it be an attractive feast, any less proportion than one-half from Cambridge. The university, too, makes larger and larger demands upon its servants; and the extraneous attractions of Cambridge itself, not to mention those of Boston, absorb more and more the time and strength of those who were wont in former years to add to the interest of the scientific meetings in Boston. Their example is followed by their juniors, and Boston itself fails to make good its own loss.

THE GEOLOGY OF THE SCOTTISH HIGHLANDS.

THE geology of the Highlands of Scotland has a peculiar interest for American students, first, because that region has many resemblances, both stratigraphical and lithological, to parts of eastern North America; and, second, because therein the same great questions which have been raised and settled with regard to New-England rocks, have there also been debated and finally solved, with similar results. There is in north-western Scotland an ancient gneissic series, which the present writer, in 1855, pointed out as the equivalent of our older gneiss, as seen in the Laurentides and the Adirondacks. Resting upon this Laurentian or Hebridean gneiss in Scotland, there is found to the east a group of quartzites and limestones containing a lower paleozoic fauna, in part, at least, Cambrian in age; while apparently overlying these fossiliferous rocks, on their eastern side, is a great series of gneisses and mica schists, rising into hills which form the western Highlands, extending south and east, and covering an area of at least fifteen thousand square miles. This whole region was studied a quarter of a century since by Murchison, aided by Ramsay and Harkness, and later by A. Geikie; and in 1858 and 1860 it was declared by Murchison that the gneisses and mica schists of the Highlands were newer than the fossiliferous strata, and were, in fact, rocks of Silurian age in an altered or metamorphic condition. As I pointed out in 1860, the parallelism between these Scottish rocks and those of New England and eastern Canada is evident. The ancient gneiss of the Adirondacks, the paleozoic strata of the Champlain basin, and the crystalline schists of the New-England Highlands, then regarded by most American geologists as of paleozoic age, are a counterpart of the strata of north-western Scotland, and I am aware that Murchison was sustained by these resemblances in his view of the age of the Scottish Highlands. It was, however, then opposed by Nicol, who maintained that these rocks, though distinct from those of the west coast, were, nevertheless, more ancient than the fossiliferous Cambrian found along their western base. I at that time shared the common belief of the metamorphic school of American geologists, and, extending it to the Scottish rocks. supported the thesis of Murchison and his colleagues against that of Nicol. When, however, I became satisfied of the errors of this school, and asserted the pre-Cambrian age of the various

groups of crystalline schists of the Atlantic belt in North America, I declared, in an address before the American association for the advancement of science, in 1871, my conviction that the crystalline schists of the Scottish Highlands "will be found . . . to belong to a period anterior to the deposition of the Cambrian sediments, and will correspond to the newer gneissic series of our Appalachian region." My studies of these, and of similar crystalline rocks in North America, in the British Islands, and in continental Europe, served in succeeding years to confirm this conclusion as to the gneiss of the Highlands, which was again asserted before the geological society of London in 1881.

Meanwhile the attention of able workers in Great Britain had been turned to this great problem in Scottish geology, beginning with Hicks in 1878, and followed by Callaway and Lapworth, all of whom labored independently of each other, but with concordant results. Their separate conclusions, as announced from time to time, but more fully in 1883, agreed in showing that the views of Murchison and his followers were altogether untenable, and in disaccord with the facts of stratigraphy. According to the results of these observers, published early in 1883, there are seen in the Highland region an older granitoid or Laurentian gneiss, and a younger series, consisting in large part of tender gray gneisses and granulites, with mica schists, which are the characteristic rocks of the Highlands, and have been variously named Upper Pebidian, Grampian, and Caledonian. They are indistinguishable from the younger gneisses of the Alps, and from the Montalban of North America, to which they were already referred in 1871. The unconformable superposition of the younger upon the older gneissic series, and the fact that the Cambrian strata rest unconformably upon both, and are younger than either, are also shown. The existence of great parallel north and south faults, with upthrows on their east sides, bringing up successively higher rocks; the fact that these faults pass into sigmoid flexures, in which both the younger gneiss and the Cambrian rocks were involved; and also that the younger gneiss is made to overlie the latter by dislocations, which were accompanied by a great thrust from the east, throwing both series into a succession of folds overturned to the west, giving the whole region a general eastern dip, — were made apparent, as may be seen in the various papers of Hicks, particularly that in the *Quarterly geological journal* for May, 1883, with appended notes by Bonney, and in the papers in the *Geological magazine* for the same year, by Callaway and by Lapworth, the latter entitled 'The secret of the Highlands,' besides a later one by Callaway in the same magazine for May, 1884, on Progressive metamorphism. An abstract of these results will be found in a chapter on the progress of geology, in the Smithsonian report for 1883.

The publication of these conclusions impelled the geological survey of Great Britain to direct its attention to the region for the purpose of defending, if possible, the previously expressed opinions of the official geologists; and, after investigations carried on in 1883 and 1884, the conclusions of the director, A. Geikie, and of his assistants, Messrs. Peach and Horne, are given in *Nature* for Nov. 13, 1884, and reprinted in the *American journal of science* for January, 1885. Therein, while making no special reference to the results obtained by his immediate predecessors, Geikie abandons entirely the views hitherto held by him in common with Murchison and Ramsay, and confirms those of Hicks, Callaway, and Lapworth. He writes that he has "found the evidence altogether overwhelming against the upward succession which Murchison believed to exist in Eriboll from the base of the Silurian [Cambrian] strata into an upper conformable series of schists and gneisses," and adds, "that there is no longer any evidence of a regular conformable passage from fossiliferous Silurian [Cambrian] quartzites, shales, and limestones, upwards into crystalline schists, which were supposed to be metamorphic Silurian sediments, must be frankly admitted." The same conclusions are also reached by Geikie from the re-examinations of similar sections in Rossshire, previously described by himself in accordance with the views of Murchison. The preliminary report of Messrs. Peach and Horne, with a general section, explains the structure in complete accordance with the statements already made by late observers, as explained above.

Geikie, in the paper just cited, calls attention to the laminated and schistose structure developed by the great pressure and friction along the lines of movement in the displaced gneissic and hornblendic rocks, and also to similar changes produced by the same agency in detrital rocks, such as arkose in this region. Both of these structural alterations are apparently included by Geikie under the head of what he calls a 'regional metamorphism.' This, however, is a misapplication of the term, likely to confuse and mislead the reader, since local

structural changes induced by mechanical movements in ancient crystalline rocks have nothing in common with that mysterious process which has been supposed by the metamorphic school to generate similar crystalline rocks from non-crystalline sediments. As regards the changes wrought by the same agency in detrital masses, it may be repeated that "the resemblances between primitive crystalline rocks and what we know to be detrital rocks, compressed, recemented, and often exhibiting interstitial minerals of secondary origin, are too slight and superficial to deceive the critical student, and disappear under microscopical investigation."

The doctrine of a regional and progressive metamorphism as the origin of the crystalline rocks, which was very widely received a generation since, both in Europe and America, has within the last fourteen years become greatly discredited. In the Alps, where it was first seriously applied, as well as in Great Britain, it is now generally abandoned. Callaway wrote not long since, that "every case of supposed metamorphic Cambrian and Silurian has been invalidated by recent researches;" and Bonney, now president of the Geological society of London, declared, in 1883, that the hitherto accredited "instances of metamorphism in Wales, and especially in Anglesea, in Cornwall, in Leicestershire, and in Worcestershire, have utterly broken down on careful study," as had already been the case in the Alps, and, it may be added, in North America. The official geologists in Great Britain, representing the traditions of the old school, have, however, hitherto held to the Scottish Highlands as their last stronghold, which they are now forced to abandon, — a substantial victory for rational geology.

T. STERRY HUNT.

Montreal, Jan. 10.

THE BASIN OF THE CARIBBEAN.

THE U. S. hydrographic office having sent to the New-Orleans exposition, as part of its exhibit, a model of the Caribbean Sea, it will be interesting at this time to discuss the deep-sea soundings taken by officers of the navy in the coast-survey steamer Blake, and in the fish-commission steamer Albatross, from 1878 to 1884, by means of which this model was constructed.

Particular attention was called to this great basin in the coast-survey reports for 1880 and 1881, and also in a paper read by the writer before the American Geographical Society in the winter of 1882.

It was not possible, however, to give the contour of the bed of this sea until the completion of the work of the Albatross last winter. The data then obtained permitted the construction of the accompanying chart, which is a faithful representation of the model before mentioned, and by means of which it will be easy to draw attention to some of its most important features.

During the cruise of the Challenger, it was demonstrated that in a submarine lake the temperature is constant to the greatest depth, and the same as that of the ocean at the depth of the rim of the lake at its lowest or deepest point.

The investigations of the temperature of the Gulf of Mexico by Commander Sigsbee, from 1874 to 1878, had shown that below a depth of 800 fathoms the temperature is constant at 39½°, which is the normal temperature of the ocean at that depth in the region of the Equatorial Current. It was evident, therefore, that the Caribbean Sea, from which the Gulf of Mexico receives its waters, must be enclosed by a rim which at its deepest part was 800 fathoms below the surface.

The purpose of the investigations of the Blake, during the time that I had the honor to command, was to verify the deduction thus made, and to determine the position and height of this rim, which limits the low temperature of the waters of the Gulf of Mexico.

All the passages between the islands from Trinidad to Cuba were carefully sounded, and the existence and position of the rim definitely established. At the same time temperatures were taken both outside and inside the basin, and at the points of minimum depth. With one exception, however, the only place where the rim was sufficiently low to admit water of the required temperature (39½°) was in the windward passage. In all other places the depths on the rim were much less than 800 fathoms.

The exception noted was a narrow gully of 1,100 fathoms, with a bottom temperature of 38°, leading into a basin of 2,400 fathoms between Santa Cruz and St. Thomas; this great depth also having a bottom temperature of 38°. As the temperature at 1,500 fathoms just south of Mona Passage was 39½°, there could be no doubt of the existence of a rim from Santa Cruz to Puerto Rico. The Albatross, therefore, was directed to examine this locality, and, as was expected, found the ridge with 900 fathoms on it at the greatest depth, and a least